

App. No. 10/848,742
Office Action Dated April 14, 2005
Amd. Dated July 14, 2005

IN THE CLAIMS

Amendments To The Claims:

This listing of claims will replace all prior versions and listings of claims in the application:

Listing of Claims:

1. (Previously presented) A magneto-resistive element, comprising:
 - an intermediate layer; and
 - a pair of magnetic layers sandwiching the intermediate layer;
 - wherein one of the magnetic layers is a free magnetic layer in which magnetization rotation with respect to an external magnetic field is easier than in the other magnetic layer;
 - wherein the free magnetic layer is a multilayer film including at least one non-magnetic layer and magnetic layers sandwiching the non-magnetic layer;
 - an element area, which is defined by the area of the intermediate layer through which current flows perpendicular to the film plane, is not larger than $1000\mu\text{m}^2$; and
 - the non-magnetic layer has a thickness d in the range of $2.6 \text{ nm} \leq d < 10 \text{ nm}$.
2. (Original) The magneto-resistive element according to claim 1, wherein an area of the free magnetic layer is larger than the element area.
3. (Original) The magneto-resistive element according to claim 1, wherein, when the magnetic layers m are the magnetic layers in the free magnetic layer that are arranged at

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positions m (with m being an integer of 1 or greater) from the intermediate layer, M_m is an average saturation magnetization of the magnetic layers m and d_m is their respective average layer thickness, then the sum of the products M_m×d_m for odd m is substantially equal to the sum of the products M_m×d_m for even m.

4. (Cancelled)

5. (Currently amended) The magneto-resistive element according to ~~any~~ of claim 1, wherein, when the magnetic layers m are the magnetic layers in the free magnetic layer that are arranged at positions m (with m being an integer of 1 or greater) from the intermediate layer, M_m is an average saturation magnetization of the magnetic layers m and d_m is their respective average layer thickness, then the sum of the products M_m×d_m for odd m is different from the sum of the products M_m×d_m for even m.

6-11 (Cancelled)

12. (Original) The magneto-resistive element according to claim 5, further comprising a second intermediate layer, wherein the free magnetic layer, which is made of a multilayer film, is sandwiched by the intermediate layers.

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13. (Original) The magneto-resistive element according to claim 12, wherein the free magnetic layer, which is made of a multilayer film, is made of $2n$ magnetic layers (with n being an integer of 1 or greater) and $2n-1$ non-magnetic layers layered in alternation.

14. (Original) The magneto-resistive element according to claim 13, further comprising a first pinned magnetic layer and a second pinned magnetic layer, wherein the first pinned magnetic layer, the first intermediate layer, the free magnetic layer, the second intermediate layer and the second pinned magnetic layer formed in that order, wherein the free magnetic layer is a multilayer film comprising a first magnetic layer, a non-magnetic layer and a second magnetic layer formed in that order from the side of the first pinned magnetic layer, and wherein, when an average film thickness of the magnetic layer n (with n being 1 or 2) is d_n , and its average saturation magnetization is M_n , then $M_2 \times d_2 \neq M_1 \times d_1$.

15. (Original) The magneto-resistive element according to claim 12, wherein the free magnetic layer, which is made of a multilayer film, is made of $2n+1$ magnetic layers (with n being an integer of 1 or greater) and $2n$ non-magnetic layers layered in alternation.

16. (Original) The magneto-resistive element according to claim 15, further comprising a first pinned magnetic layer and a second pinned layer, wherein the first pinned magnetic layer, the first intermediate layer, the free magnetic layer, the second

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intermediate layer and the second pinned magnetic layer formed in that order, wherein the free magnetic layer is a multilayer film comprising a first magnetic layer, a first non-magnetic layer, a second magnetic layer, a second non-magnetic layer and a third magnetic layer formed in that order from the side of the first pinned magnetic layer, and wherein, when an average film thickness of the magnetic layer n is d_n (with n being 1, 2 or 3), and its average saturation magnetization is M_n , then $M_3 \times d_3 + M_1 \times d_1 \neq M_2 \times d_2$.

17. (Original) The magneto-resistive element according to claim 1, wherein at least one of the magnetic layers in the free magnetic layer has a coercivity or saturation magnetization that is different from at least one of the other magnetic layers.

18 - 38 (Cancelled)

39. (Original) The magneto-resistive element according to claim 1, wherein the intermediate layer is made of an insulator or a semiconductor including at least one element selected from the group consisting of oxygen, nitrogen, carbon and boron.

40. (Cancelled)

41. (Original) The magneto-resistive element according to claim 1,

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wherein the intermediate layer is made of at least one metal selected from transition metals, or at least one conductive compound selected from compounds of transition metals with oxygen, nitrogen and boron; and
wherein the element area is not larger than $0.01\mu\text{m}^2$.

42. (Original) The magneto-resistive element according to claim 41, wherein at least one of the magnetic layers sandwiching the intermediate layer comprises a ferromagnetic material including oxygen, nitrogen or carbon, or an amorphous ferromagnetic material.

43 - 44 (Cancelled)

45. (Original) The magneto-resistive element according to claim 1, wherein the free magnetic layer serves as a magnetic memory layer.

46. (Cancelled)

47. (Original) The magneto-resistive element according to claim 1, further comprising a flux guide.

48. (Original) The magneto-resistive element according to claim 47, wherein at least a portion of the free magnetic layer serves as the flux guide.

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49 - 50 (Cancelled)

51. (Original) The magneto-resistive element according to claim 1, wherein, when "a" is the longest width of the element shape of the free magnetic layer, and "b" is its shortest width, then a/b is in the range of $1.5 < a/b < 10$.

52-58 (Cancelled)

59. (Original) A data communication terminal equipped with a plurality of magneto-resistive elements according to claim 1, wherein data that have been communicated by electromagnetic waves are stored in the free magnetic layers of the magneto-resistive elements.

60. (Cancelled)

61. (Original) The magneto-resistive element according to claim 12, comprising a first pinned magnetic layer, a first intermediate layer, a first free magnetic layer, a non-magnetic conductive layer, a second free magnetic layer, an second intermediate layer and a second pinned magnetic layer formed in that order, wherein at least one of the first free magnetic layer and the second free magnetic layer includes one or more magnetic layers and one or more non-magnetic layers layered in alternation.

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62. (Original) The magneto-resistive element according to claim 61, wherein magnetic layers that are adjacent but spaced apart by a non-magnetic conductive layer are magnetized antiparallel to one another.

63. (Original) The magneto-resistive element according to claim 61, wherein the non-magnetic conductive layer has a thickness of 2.6nm to 50nm.

64. (Cancelled)

65. (Currently amended) The magneto-resistive element according to claim 1, comprising a pinned magnetic layer, an intermediate layer and a free magnetic layer, wherein the free magnetic layer is in contact with a buffer layer, wherein the buffer layer is made of a composition including a non-magnetic element, in which 10wt% to 50wt% of a non-magnetic element is ~~added to also present in a composition of a magnetic layer~~ in contact with the buffer layer, and wherein the saturation magnetization of said composition is not more than 0.2T.

66. (Currently amended) The magneto-resistive element according to claim 65, wherein the ~~buffer layer~~ non-magnetic element comprises at least one selected from the group consisting of Cr, Mo and W.

67 – 68. (Cancelled)

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69. (Original) The magneto-resistive element according to claim 1, wherein the free magnetic layer is made of at least one non-magnetic layer and magnetic layers sandwiching the non-magnetic layer, and wherein a total film thickness of the magnetic layers is at least 4nm.

70. (Cancelled)

71. (Original) The magneto-resistive element according to claim 1, wherein the non-magnetic layer comprises at least one compound selected from the group consisting of oxides, nitrides, carbides and borides.

72. (Original) The magneto-resistive element according to claim 71, wherein the non-magnetic layer is a multilayer film including at least one layer of non-magnetic metal and at least one layer of non-magnetic material selected from the group consisting of oxides, nitrides, carbides and borides.